

# Climate Action Team Public Health Work Group

## Climate Change and Agriculture



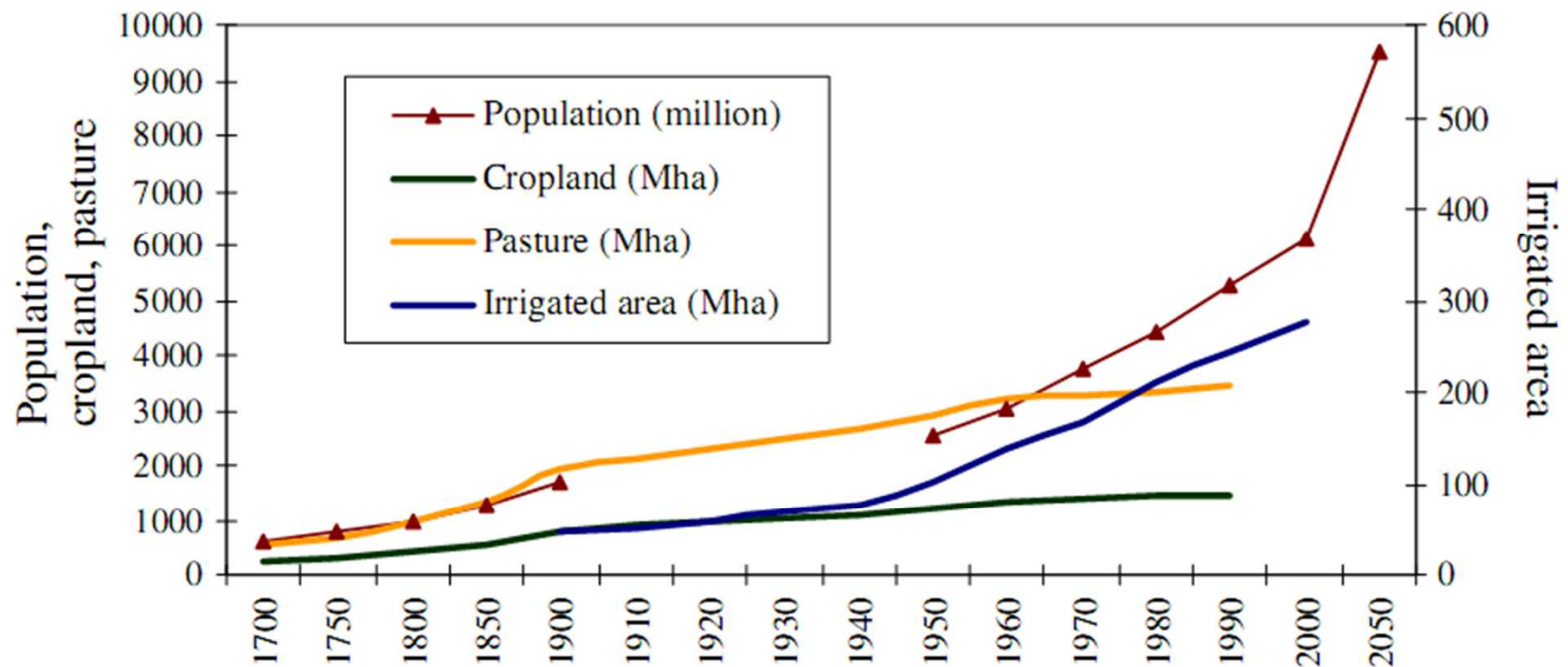
Amrith Gunasekara, PhD

Science Advisor to the Secretary  
California Department of Food and Agriculture  
<http://www.cdfa.ca.gov/>

April 30, 2012  
CalEPA  
Sacramento, CA

# Agriculture and Human Population Growth

## Challenges for agriculture



**Fig. 2.** Global food chain and human population growth (Khan and Hanjra, 2009 and references therein).

# Climate Change in California



[Home](#) | [Sponsors](#) | [Background](#) | [Complementary Events](#) | [Conference Materials](#)

## Conference Home

"It's time for courage, it's time for creativity and it's time for boldness to tackle climate change."

- Governor Brown, Sept 13, 2011

View the conference on video: [Part 1](#) | [Part 2](#) | [Part 3](#) | [Part 4](#)

On December 15, Governor Edmund G. Brown Jr. and environmental, business and public health and safety leaders came together at The Governor's Conference on Extreme Climate Risks and California's Future.

The Governor's Conference focused on the threats of unpredictable and extreme weather events on the state's economy, business sectors, public health and natural resources. Attendees discussed the best ways to prepare and protect our state and adapt to these growing risks.

The Governor's Conference built on the findings of a United Nations' Intergovernmental Panel on Climate Change (IPCC) report outlining the link between global warming, extreme weather events and their economic impact.

Through 2012, [complementary events](#) are being held throughout the state to provide for in-depth review of certain extreme weather threats and potential solutions.

# Climate Change in California



## Complementary Events

*November 9, 2011*

**Cal EMA Executive Flood Seminar**



*November 16, 2011*

**The Impact of Extreme Events and Climate Change  
on California's Food Supply**



*December 13, 2011*

**Vulnerability and Adaptation to Extreme Events in  
California in the Context of a Changing Climate**



*April 9, 2012*

**Confronting Climate Change: A Focus on Local  
Government Impacts, Actions and Resources**



[http://www.climatechange.ca.gov/ecrcf/co\\_events.html](http://www.climatechange.ca.gov/ecrcf/co_events.html)

# News Release

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

**Media Contacts:**

Steve Lyle, CDFA Public Affairs, (916) 654-0462, [steve.lyle@cdfa.ca.gov](mailto:steve.lyle@cdfa.ca.gov)



## STATE BOARD OF FOOD AND AGRICULTURE TO DISCUSS EXTREME CLIMATE RISKS ON NOVEMBER 16 IN SACRAMENTO EVENT ASSOCIATED WITH GOVERNOR BROWN'S EXTREME EVENTS CONFERENCE IN DECEMBER



Release #11-062

[Print This Release](#)

SACRAMENTO, November 10, 2011 - The California State Board of Food and Agriculture, in partnership with the California Department of Food and Agriculture, is hosting a forum on Extreme Climate Risks and California's Future - Agriculture and the Food System on November 16, 2011 in Sacramento. The forum will provide an overview of the potential impact of climate change on California's food and farming sector.

"Worldwide we have seen an increase in volatile weather events that have had significant impact on global food supplies," said CDFA Secretary Karen Ross. "As one of the key growing regions in the United States, California must be prepared for effects of a changing climate and what this means for food production."

The forum will be held on Wednesday, November 16, 2011 from 10:00 a.m. to 2:30 p.m. at the California Department of Food and Agriculture, 1220 N Street, Sacramento, CA 95814. A variety of speakers representing academia and federal, state and local government will address adaptation to climate change, economic impact and extreme event planning. Keynote presentations will be provided by Lucinda Roth,

# Climate Change Predictions

**Lucinda Roth**

Climate Change Specialist  
USDA NRCS

Is climate change happening?

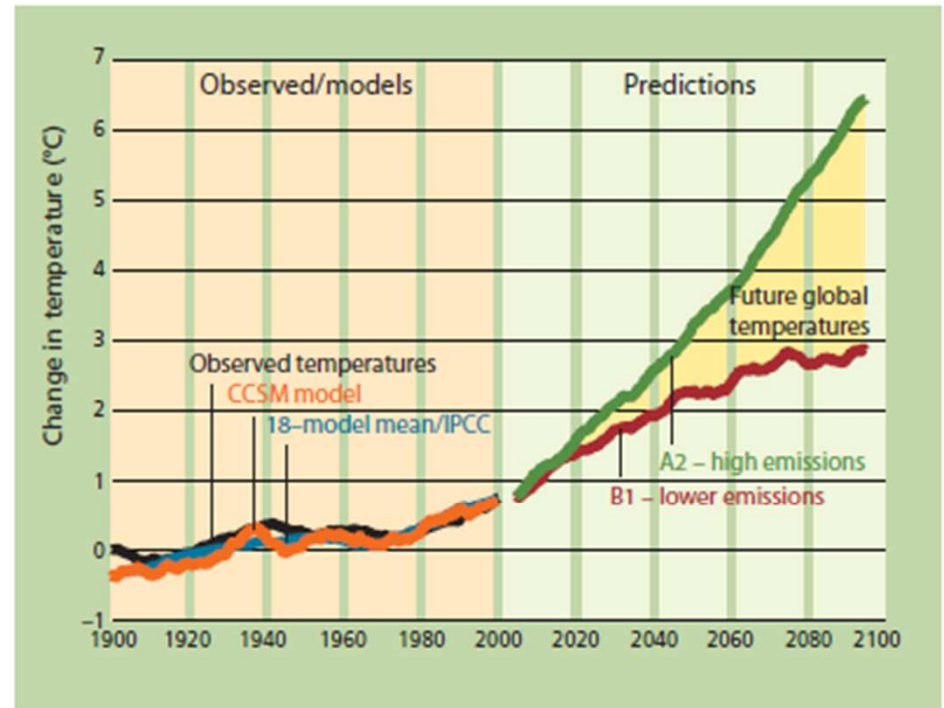
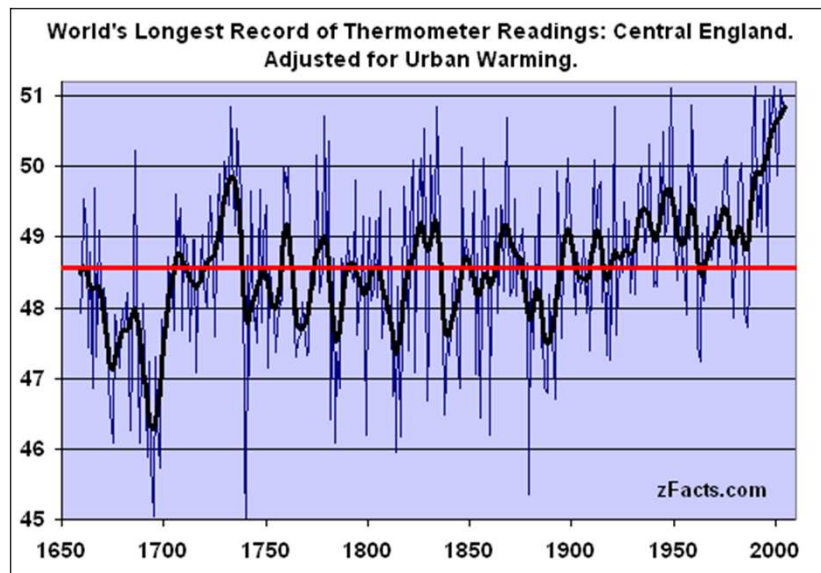
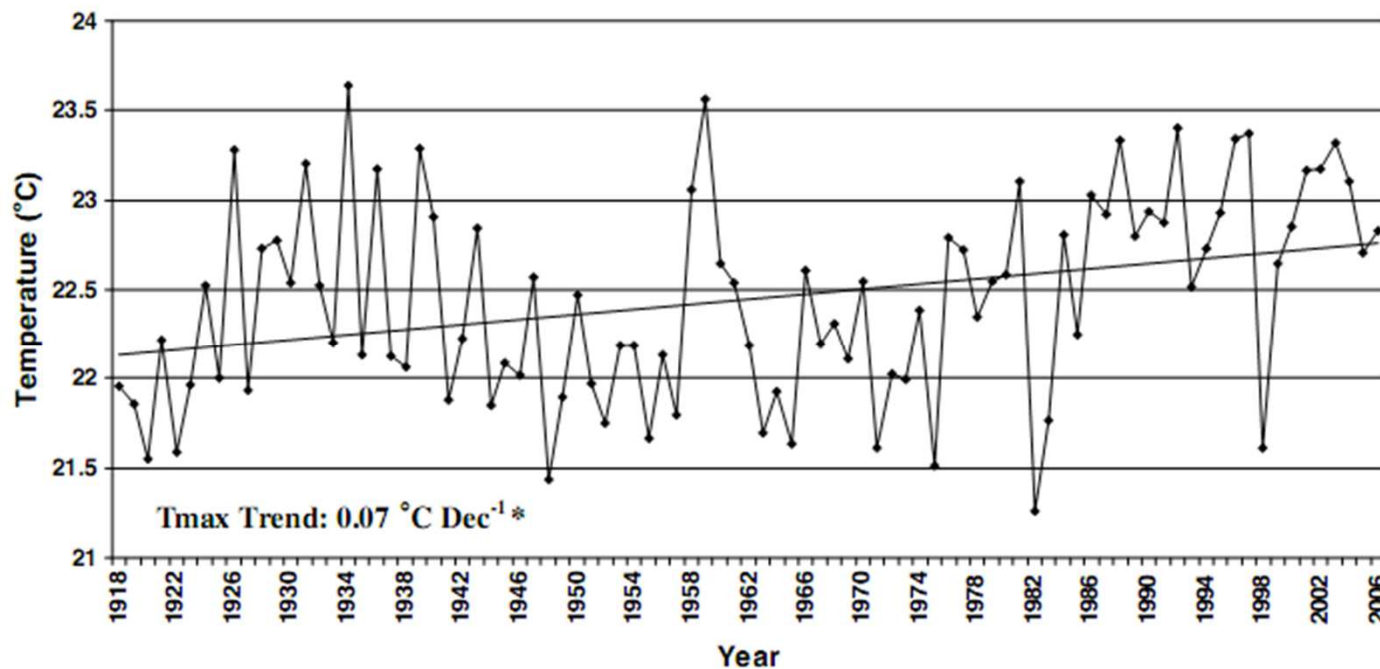
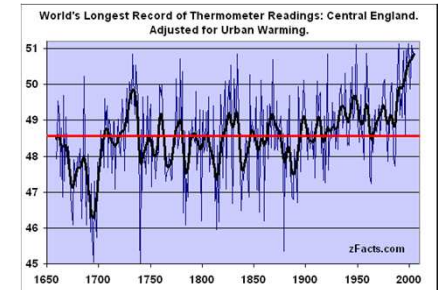


Fig. 3. Observed and predicted changes in average surface temperatures in the Northern Hemisphere. Observed/models (left) shows: observed temperatures between 1900 and 2000 (Mitchell and Jones 2005); 18-model mean sample of IPCC global ocean-atmosphere predictions starting about 1850, for 1900 to 2000; and Community Climate System Model (CCSM) prediction for 1900 to 2000. CCSM predictions (right) for 2000 to 2100 are based on the A2 (high emissions) and moderate B1 (lower emissions) economic scenarios. The likely range of global temperatures in the future is between the green and red lines.

# Climate Change in California



Is it happening in California?



# Climate Change and CDFA



**Dr. Louise Jackson**

University of California Davis

## Challenges for Agricultural Landscapes



### Extreme weather events

- Less water – water efficiency and management
- Fruit and nut crops sensitive to temp changes
- Crop pests
- Dairy cow milk production yields – heat stress
- Insufficient chill hours (below 45°)

# Climate Change and Agriculture



- Insufficient chill hours (below 45°)

Chilling requirements for many tree crops need to be fulfilled each winter to ensure homogeneous flowering and fruitset, and generate economically sufficient yields (optimize yields).

Insufficient winter chill can severely reduce crop yields and crop quality.

When chilling requirements are not completely fulfilled, trees display irregular and temporally spread out flowering, leading to inhomogeneous crop development.

# Climate Change and Agriculture

## Los Angeles Times | LOCAL

### Climate change could put the heat on California crops

Fruit and nut orchards in the Central Valley rely on winter chilling hours, but those are in decline, according to a UC Davis study.

Only 4% of the Central Valley is now suitable for apples, cherries and pears, all high-chill fruits that could once be grown in half the valley, according to the UC Davis study.

By the end of the century, UC Davis study says, "areas where safe winter chill exists for growing walnuts, pistachios, peaches, apricots, plums and cherries are likely to almost completely disappear."



San Joaquin Valley walnut farmer Chris Locke has noticed a change in the weather, with less frigid fog and more sunny days. Winter chilling hours have declined as much as 30% since 1950 in large swaths of the Central Valley, according to a UC Davis study. (Robert Durell / July 20, 2009)

#### Climatic Changes Lead to Declining Winter Chill for Fruit and Nut Trees in California during 1950–2099

Eike Luedeling<sup>1,2\*</sup>, Minghua Zhang<sup>1\*</sup>, Evan H. Girvetz<sup>3</sup>

<sup>1</sup> Department of Land, Air and Water Resources, University of California Davis, Davis, California, United States of America, <sup>2</sup> Department of Plant Sciences, University of California Davis, Davis, California, United States of America, <sup>3</sup> College of Forest Resources, University of Washington, Seattle, Washington, United States of America

# Climate Change and Agriculture

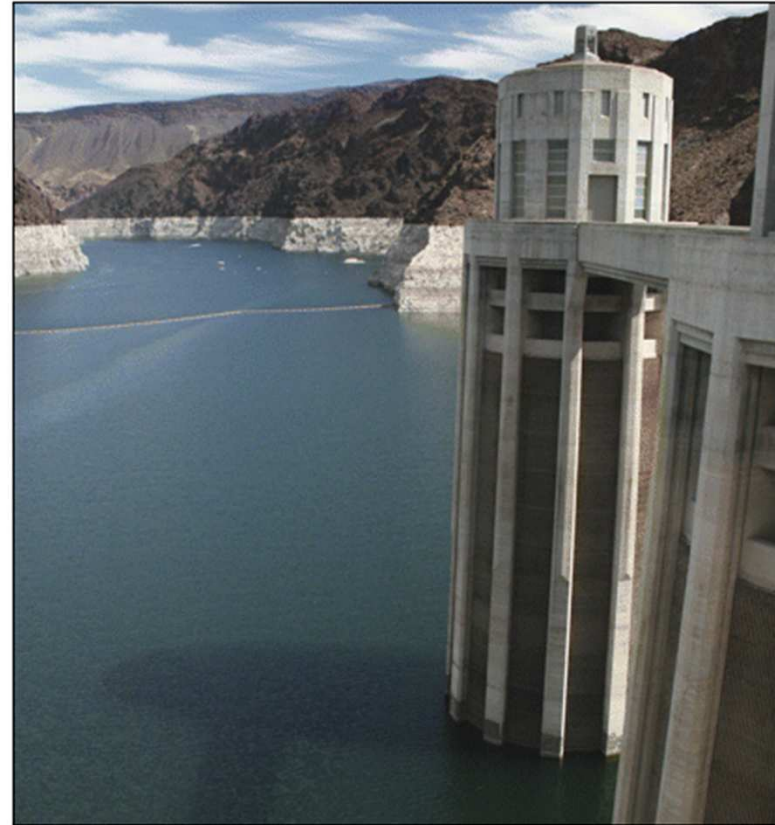
**Dr. Glen MacDonald**  
Institute on Environment  
and Sustainability  
UCLA

## Drought



Proceedings of the National Academy of Sciences

MacDonald G. 2010. PNAS. 107: 21256–21262.



**Cover image:** Pictured is an intake tower of the Hoover Dam on Lake Mead near Las Vegas, Nevada. The largest reservoir in the United States, Lake Mead is now at slightly more than one third its capacity. Since 2000, the water level in the lake has dropped by nearly 40 m. A further drop of less than 3 m would trigger a level 1 water shortage declaration for the first time in the lake's history, potentially restricting water supply to Nevada and Arizona. See the introductory Perspective by Glen M. MacDonald on pages [21256–21262](#) for the Climate Change and Water in Southwestern North America Special Feature. Image courtesy of Glen M. MacDonald.

# Climate Change and Agriculture

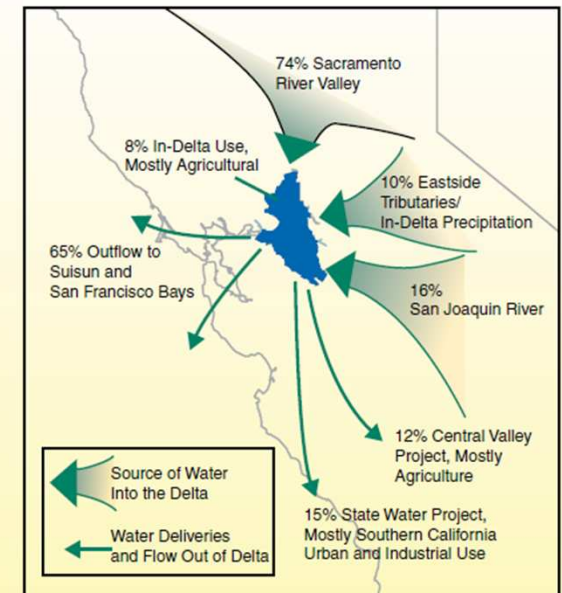
**Kamyar Guivetchi**  
California Department of  
Water Resources

## Water Supply

- Water Distribution in state
- Water supply in state
- Snow pack
- Heat stress on H<sub>2</sub>O supply



## Delta Is at the Heart of The California Water System



# Climate Change and Agriculture



## How California Can Respond to Climate Change?

Justin Malan, California Climate and Agriculture Network

Kurt Malchow, Cal-Adapt

Courtney Albrecht, CDFA

*Global Change Biology* (2011) 17, 228–238, doi: 10.1111/j.1365-2486.2010.02227.x

### Climate change effects on walnut pests in California

EIKE LUEDELING<sup>\*†‡</sup>, KIMBERLY P. STEINMANN<sup>‡</sup>, MINGHUA ZHANG<sup>‡</sup>, PATRICK H. BROWN<sup>†</sup>, JOSEPH GRANT<sup>§</sup> and EVAN H. GIRVETZ<sup>•||</sup>

<sup>\*</sup>World Agroforestry Centre (ICRAF), PO Box 30677-00100, Gigiri, Nairobi, Kenya, <sup>†</sup>Department of Plant Sciences, University of California Davis, Davis, CA 95616, USA, <sup>‡</sup>Department of Land, Air and Water Resources, University of California Davis, Davis, CA 95616, USA, <sup>§</sup>University of California Cooperative Extension, Stockton, CA 95206, USA, <sup>•</sup>The Nature Conservancy Global Climate Change Program, Seattle, WA 98101, USA, <sup>||</sup>School of Forest Resources, University of Washington, Seattle, WA 98195, USA

“Increasing temperatures are likely to change pest dynamics in California, according to all future climate scenarios analyzed.”

“Generation numbers of codling moth, navel orangeworm, web-spinning spider mites and European red mites are likely to increase, generating new challenges for pest control.”

# Climate Change, Agriculture, and Public Health



We talked a lot about the following;

- Drought, Water availability, Flooding, Insurance, Chill hours Temperature, Invasive species, Food supply, Local level planning

We did not talk about what we have here today to discuss....the important relationship between extreme events (climate change), food supply (agriculture), and nutritional availability (public health)

- Food chain, Food safety, Food production reliability, Food supply, Local level planning

# Agriculture in California



- Mediterranean climate
- Some of the most fertile agricultural soils in the world (e.g., Central Coast)
- More than half the nation's fruits, vegetables, nuts
- Year round production in some areas
  - Lemons, artichokes, avocados, broccoli, cabbage, carrots, cauliflower, celery, lettuce, mushrooms, potatoes, spinach, squash
- The most specialty crops in the nation (99%)
  - Almonds, artichokes, figs, grapes, raisins, kiwi fruit, olives, peaches, pistachios, walnuts, plums, pomegranates

# Agriculture in California



## Specialty Crops (USDA AMS Definition)

"Specialty crops are defined in law as "fruits and vegetables, tree nuts, dried fruits and horticulture and nursery crops, including floriculture."

### Fruits and Tree Nuts

Almond
Apple
Apricot
Avocado
Banana
Blackberry
Blueberry
Breadfruit
Cacao
Cashew
Citrus
Cherimoya
Cherry
Chestnut (for nuts)
Coconut
Coffee
Cranberry
Currant
Date
Feijou
Fig
Filbert (hazelnut)
Gooseberry

### Vegetables

Artichoke
Asparagus
Bean
Snap or green
Lima
Dry, edible
Beet, table
Broccoli (including broccoli raab)
Brussels sprouts
Cabbage (including Chinese)
Carrot
Cauliflower
Celeriac
Celery
Chive
Collards (including kale)
Cucumber
Edamame
Eggplant
Endive
Garlic
Horseradish
Kohlrabi
Leek
Lettuce
Melon (all types)
Mushroom (cultivated)

### List of Ineligible Commodities

Alfalfa	Pod corn
Amylomaize	Primrose
Barley	Quinoa
Buckwheat	Rapeseed oil
Canola	Range grasses
Canola Oil	Rice
Clover	Rye
Cotton	Safflower meal
Cottonseed oil	Safflower oil
Dairy products	Shellfish (marine or freshwater)
Dent corn	Sorghum
Eggs	Soybean oil
Field corn	Soybeans
Fish (marine or freshwater)	Striped Maize
Flax	Sugar beets
Flaxseed	Sugarcane
Flint corn	Sunflower oil
Flower corn	Tobacco
Hay	Tofu
Livestock products	Triticale
Millet	Waxy corn
Mustard seed oil	Wheat
Oats	White corn
Peanut oil	Wild Rice
Peanuts	

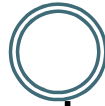
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# Agriculture in California



- California is the nation's top agricultural state, and has been for more than 50 years
- More than 60% of the state's farms are less than 50 acres in size; indicator of the number of specialty crop operations
- California remained the No. 1 state in cash farm receipts in 2010, with \$37.5 billion in revenue
- The state accounted for 16 percent of national receipts for crops, and 7 percent of the U.S. revenue for livestock and livestock products

# Agriculture in California



- California's agricultural abundance includes more than 400 commodities
- California has been the nation's leading dairy state since 1993 when it surpassed Wisconsin in milk production
- Sales of milk and cream contributed \$5.94 billion in 2010
- California ranked number one in the U.S. in the production of fluid milk, butter and nonfat dry milk
- California's dairies produced 40.4 billion pounds of milk, accounting for 21 percent of the nation's milk supply

# Climate Change in California



*Arctic, Antarctic, and Alpine Research, Vol. 43, No. 3, 2011, pp. 317–330*

## **Quantifying 20th Century Glacier Change in the Sierra Nevada, California**

*H. J. Basagic\*† and  
A. G. Fountain\**

\*Department of Geology, Portland  
State University, P.O. Box 751,  
Portland, Oregon 97207-0751, U.S.A.

†Corresponding author:  
basagic@gmail.com

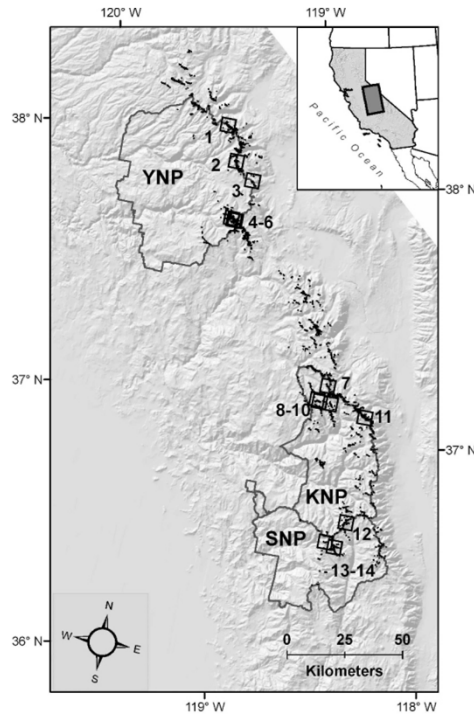
“Rapid retreat occurred over the first half of the 20th century beginning in the 1920s and continued through the 1960s”

“1980s glaciers resumed retreat with a rapid acceleration starting in the early 2000s”

“area changes in the study glaciers is a response to regional climate whereas the magnitude of change is influenced by local topographic effects”

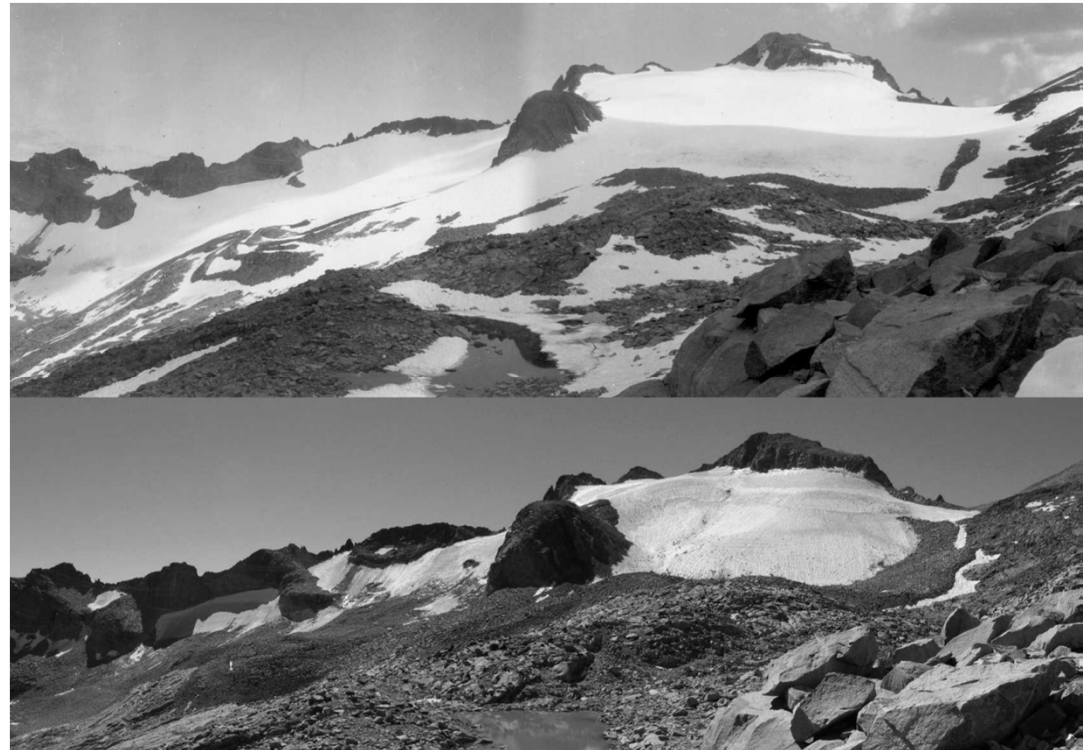
“Area changes correlate significantly with changes in summer and winter air temperatures”

# Climate Change in California



Lyell Glacier (YNP)

7 August 1903 by G. K. Gilbert (USGS)



5 September 2004 by H. Basagic.

# Agriculture and Public Health



## Climate change and children's health

Aaron S. Bernstein<sup>a,b</sup> and Samuel S. Myers<sup>c,d</sup>

<sup>a</sup>Center for Health and the Global Environment, Harvard Medical School, <sup>b</sup>Children's Hospital Boston, <sup>c</sup>Mount Auburn Hospital and <sup>d</sup>Department of Medicine, Harvard Medical School, Boston, Massachusetts, USA

Correspondence to Aaron S. Bernstein, MD, MPH, Center for Health and the Global Environment, 401 Park Drive, 2nd Floor East, Boston, MA 02215, USA  
Tel: + 1 617 384 8530; fax: +1 617 384 8585;  
e-mail: aaron\_bernstein@hms.harvard.edu

*Current Opinion in Pediatrics* 2011, 23:221–226

“Although pediatricians may readily be moved to prevent the harm that would result if children lost access to food, water, and clean air, or contracted certain vector-borne diseases, they may be less aware that climate change makes all these unwelcome outcomes more likely”

“Perhaps the single greatest health concern for children that climate change raises is its potential to greatly reduce the quantity and nutritional quality of food”

# Agriculture and Public Health



## **Climate change and children's health**

Aaron S. Bernstein<sup>a,b</sup> and Samuel S. Myers<sup>c,d</sup>

- High temperature = more pathogen and crop wilting
- Ozone increase (30-45 ppb) = crop yield decrease (10-40%)
- Rising carbon dioxide may also affect nutritional quality
  - Grains grown at elevated concentrations of CO<sub>2</sub> appear to have reduced concentrations of protein, iron, zinc, and perhaps other nutrients
  - Iron deficiency = anemia = cognitive development

# Agriculture and Public Health



**Number 5 Make half your plate fruits and vegetables**  
Choose red, orange, and dark-green vegetables like tomatoes, sweet potatoes, and broccoli, along with other vegetables for your meals. Add fruit to meals as part of main or side dishes or as dessert








# Agriculture and Public Health



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FRUITS & VEGGIES VIDEO CHALLENGE

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**The USDA is challenging you to show how you're adding more fruits and vegetables to your diet without straining your budget.**

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Congratulations, winners! And thanks to everyone who voted and participated!

<http://fruitsandveggies.challenge.gov/>

# Climate Change and CDFA



[CDFA Home](#) > [California Agricultural Vision](#)

[State Board of Food & Agriculture](#) ▶

## CALIFORNIA AGRICULTURAL VISION

Progress Report Released on Ag Vision Released (Spring 2012)

### FROM STRATEGIES TO RESULTS

Since the release of the California Agricultural Vision (Ag Vision) report in December 2010, the Ag Vision Advisory Committee has continued progress on the strategies and action items within the report to ensure a vibrant future for the state. The Ag Vision is a strategic plan for the future of the state's agricultural and food system which was motivated by the rapidly growing list of challenges facing agriculture, from regulations and water suppliers to urbanization and climate change.

The "California Agricultural Vision: From Strategies to Results" documents the ongoing progress of the Ag Vision Advisory Committee's work and that of other stakeholders in addressing the 12 key strategies for California's agriculture and food sector.

#### FORUM

[Ag Vision](#)

#### AG VISION



#### California Agricultural Vision

The California State Board of Food and Agriculture hosted seven listening sessions across the state asking for a vision of agriculture in 2030. Here is preview of those comments. (8:29)

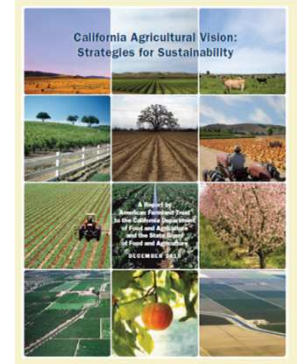
<http://www.cdfa.ca.gov/agvision/>

# Climate Change and CDFA



## Strategy 9

### Assure Agricultural Adaptation to Climate Change



Assure that all sectors of California agriculture can adapt to the most likely climate related changes in seasonal weather, water supply, pests and diseases, and other factors affecting agricultural production

# Climate Change and CDFA



## $N_2O$ from nitrogen fertilizer research

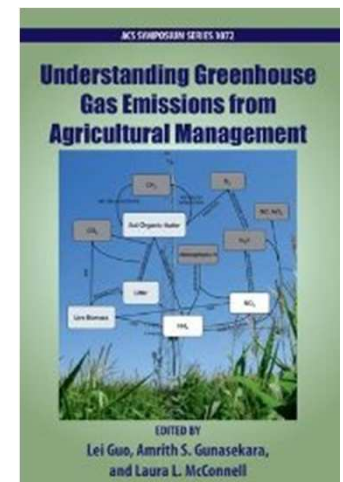
- 310 X more potent than  $CO_2$
- > \$1 million (combined funding between CEC, ARB, CDFA)
- Examined  $N_2O$  from 10 major crops in California
- Lack of baseline information
- Being evaluated as an agricultural offset protocol

## $CH_4$ dairy digester research

- 24 X more potent than  $CO_2$
- Lagoons offgas methane
- Waste to energy conversion

## Agriculture has global warming mitigation potential

- Carbon sequestration
- Research on organic matter buildup needed



# Climate Change and Public Health

Where in the cycle will climate change impact?



Henton et al. 2006. California's Food Chain at Work. CA Economic Strategic Panel.

# Climate Change and Public Health



Where in the cycle will climate change impact?

Henton et al. 2011. The Food Chain Cluster; Solano and Yolo Counties.

# Thanks

